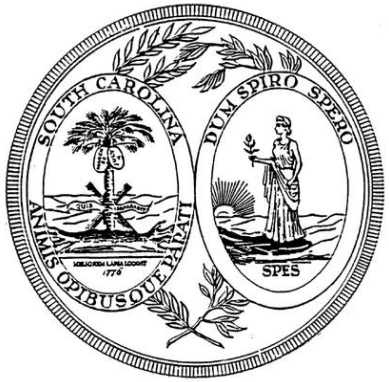
South Carolina Academic Standards and Performance Indicators for Science 2014



Instructional Unit Resource

Biology

South Carolina Academic Standards and Performance Indicators for Science 2014
Biology Instructional Unit Resource

As support for implementing the *South Carolina Academic Standards and Performance Indicators for Science 2014*, the standards for Biology have been grouped into possible units. In the Overview of Units below, the titles for those possible units are listed in columns. Refer to the Overview document to note these unit titles and how Standards, Conceptual Understandings, Performance Indicators, Science and Engineering Practices, and Crosscutting Concepts align. Following the Overview of Units, an Instructional Unit document is provided that delivers guidance and possible resources in teaching our new *South Carolina Academic Standards and Performance Indicators for Science 2014*. The purpose of this document is to provide guidance as to how all the standards in this grade may be grouped into units and how those units might look. Since this document is merely guidance, districts should implement the standards in a manner that addresses the district curriculum and the needs of students. This document is a living document and instructional leaders from around the state will continuously update and expand these resource documents. These documents will be released throughout the 2016-2017 school year with the intentionality of staying ahead of instruction. Teachers should also note that links to the Standards document, A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas, the SEP Support Document, and the Support Document 2.0 are embedded throughout the Instructional Unit format for reference.

Acknowledgments

Jean Baptiste Massieu, famous deaf educator, made a statement that is now considered a French proverb. “Gratitude is the memory of the heart. Indeed, appreciation comes when you feel grateful from the depths of your heart. The head keeps an account of all the benefits you received and gave. But the heart records the feelings of appreciation, humility, and generosity that one feels when someone showers you with kindness.” It is with sincere appreciation that we humbly acknowledge the dedication, hard work and generosity of time provided by teachers and instructional leaders across the state that have made and are continuing to make the Instructional Unit Resources possible.

Biology 1 Overview of Units

Unit 1				Unit 2	Unit 3			
Cells as a System				Energy Transfer	Heredity - Inheritance and Variation of Traits			
Standard				**Standard**	**Standard**			
H.B.2				H.B.3	H.B.4			
Conceptual Understanding				**Conceptual Understanding**	**Conceptual Understanding**			
H.B.2A	H.B.2B	H.B.2C	H.B.2D	H.B.3A	H.B.4A	H.B.4B	H.B.4C	H.B.4D
Performance Indicators	**Performance Indicators**	**Performance Indicators**	**Performance Indicators**	**Performance Indicators**	**Performance Indicators**	**Performance Indicators**	**Performance Indicators**	**Performance Indicators**
H.B.2A.1 H.B.2A.2	H.B.2B.1 H.B.2B.2 H.B.2B.3	H.B.2C.1 H.B.2C.2 H.B.2C.3	H.B.2D.1 H.B.2D.2 H.B.2D.3 H.B.2D.4	H.B.3A.1 H.B.3A.2 H.B.3A.3 H.B.3A.4 H.B.3A.5	H.B.4A.1 H.B.4A.2	H.B.4B.1 H.B.4B.2	H.B.4C.1 H.B.4C.2 H.B.4C.3	H.B.4D.1
***Science and Engineering Practices**	***Science and Engineering Practices**	***Science and Engineering Practices**	***Science and Engineering Practices**	***Science and Engineering Practices**	***Science and Engineering Practices**	***Science and Engineering Practices**	***Science and Engineering Practices**	***Science and Engineering Practices**
H.B.1A.6 H.B.1A.3	H.B.1A.2 H.B.1A.6 H.B.1A.8	H.B.1A.1 H.B.1A.2 H.B.1A.4	H.B.1A.2 H.B.1A.6 H.B.1A.7	H.B.1A.2 H.B.1A.3 H.B.1A.7	H.B.1A.2	H.B.1A.2 H.B.1A.8	H.B.1A.2 H.B.1A.4 H.B.1A.6	H.B.4A.2
***Crosscutting Concepts**				***Crosscutting Concepts**	***Crosscutting Concepts**			
2, 4, 5, 6, 7				2, 4, 5	2, 3, 4, 6			

**Teachers have the discretion to enhance the selected SEP's and CCC's.*

Biology 1 Overview of Units

Unit 4	**Unit 5**			
Evolution	Ecosystem Dynamics			
Standard	**Standards**			
H.B.5	H.B.6			
Conceptual Understanding	**Conceptual Understanding**			
N/A	H.B.6A	H.B.6B	H.B.6C	H.B.6D
Performance Indicators	**Performance Indicators**	**Performance Indicators**	**Performance Indicators**	**Performance Indicators**
H.B.5.1 H.B.5.2 H.B.5.3 H.B.5.4 H.B.5.5 H.B.5.6 H.B.5.7	H.B.6A.1 H.B.6A.2	H.B.6B.1 H.B.6B.2	H.B.6C.1	H.B.6D.1
***Science and Engineering Practices**	***Science and Engineering Practices**	***Science and Engineering Practices**	***Science and Engineering Practices**	***Science and Engineering Practices**
****This standard is currently based on the 2005 Standards document.***	H.B.1A.4 H.B.1A.5	H.B.1A.2 H.B.1A.6	H.B.1A.7	H.B.1B.1
***CrossCtting Concepts**	***CrossCutting Concepts**			
1, 2, 3, 7	1, 2, 3, 4, 5, 6, 7			

**Teachers have the discretion to enhance the selected SEP's and CCC's.*

Unit Title
Biology: Heredity - Inheritance and Variation of Traits
Standard http://ed.sc.gov/scdoe/assets/file/agency/ccr/Standards-Learning/documents/South_Carolina_Academic_Standards_and_Performance_Indicators_for_Science_2014.pdf
H.B.4 The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes.

Conceptual Understanding
H.B.4A Each chromosome consists of a single DNA molecule. Each gene on the chromosome is a particular segment of DNA. The chemical structure of DNA provides a mechanism that ensures that information is preserved and transferred to subsequent generations.
New Academic Vocabulary **Some students may need extra support with the following academic vocabulary in order to understand what they are being asked to understand and do. Teaching these terms in an instructional context is recommended rather than teaching the words in isolation. A great time to deliver explicit instruction for the terms would be during the modeling process. Ultimately, the student should be able to use the academic vocabulary in conversation with peers and teachers. These terms are pulled from the essential knowledge portion of the Support Doc 2.0 (http://ed.sc.gov/instruction/standards-learning/science/support-documents-and-resources/) and further inquiry into the terms can be found there.**
Chromosome DNA RNA Autosomes Sex Chromosomes Gene Nucleotide Sequences
Performance Indicators **Text highlighted below in *orange* and *italicized/underlined* shows connections to SEP's**
H.B.4A.1 *Develop and use models* at different scales to explain the relationship between DNA, genes, and chromosomes in coding the instructions for characteristic traits transferred from parent to offspring. H.B.4A.2 *Develop and use models* to explain how genetic information (DNA) is copied for transmission to subsequent generations of cells (mitosis).
***Science and Engineering Practices** **Support for the guidance, overviews of learning progressions, and explicit details of each SEP can found in the Science and Engineering Support Doc (http://ed.sc.gov/scdoe/assets/File/instruction/standards/Science/Support%20Documents/Complete_2014SEPsGuide_SupportDoc2_0.pdf). It is important that teachers realize that the nine science and engineering practices are not intended to be used in isolation. Even if a performance indicator for a given standard only lists one of the practices as a performance expectation, scientists and engineers do not use these practices in isolation, but rather as part of an overall sequence of practice. When educators design the learning for their students, it is important that they see how a given performance expectation fits into the broader context of the other science and engineering practices. This will allow**

teachers to provide comprehensive, authentic learning experiences through which students will develop and demonstrate a deep understanding of scientific concepts.
H.B.1A.2 Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others.
***Cross Cutting Concepts** **(http://www.nap.edu/read/13165/chapter/8)** The link above provides support from the Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (2012) The text in blue and *italicized/underlined* below provides a brief explanation of how the specific content ties to the CCC's.
2. Cause and effect: The National Research Council (2012) states "events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts" (p. 84). *The ordering of specific bases causes a particular trait to occur.* 3. Scale, proportion, and quantity: The National Research Council (2012) states that "in considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance" (p. 84). *The ideas of ratio and proportionality are important, along with being able to predict the effect of a change in one variable on another.* 4. Systems and systems models: The National Research Council (2012) states that "Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering" (p. 84). *Genes are composed of DNA. Chromosomes are composed of genes. The universality of life shows itself in a common genetic code.* 6. Structure and function: The National Research Council (2012) states that "the way in which an object or living thing is shaped and its substructure determine many of its properties and functions " (p. 84). *The double helix structure provides DNA the flexibility to condense into chromosomes. The complementary base pairing of DNA provides a unique code that gets passed down over generations.*

**Teachers have the discretion to enhance the selected SEP's and CCC's.*

Prior Knowledge
• 7.L.4.A Inherited Traits, Alleles, Genes, Chromosomes, DNA and RNA
Subsequent Knowledge
• N/A

Possible Instructional Strategies/Lessons
Strategies and lessons that will enable students to master the standard and/or indicator.

- Journey Into Human DNA This interactive simulation takes the user on a journey from outside the body all the way down to the molecular level. The resource can be found at: http://www.pbs.org/wgbh/nova/body/journey-into-human-dna.htm

- 3D Models Create a written and/or 3D model of a DNA molecule that explains the relationship between DNA, genes, and chromosomes. Students can use creative materials for their DNA model, as long as they can show the relationship. The model can also be interactive to demonstrate the basic process of DNA replication (e.g. the strands separate so new nucleotides can be matched to existing strands). *This strategy is also included in H.B.4B

- DNA - The Double Helix Game Students will actively model DNA replication by becoming the DNA polymerase and assembling two identical DNA strands. This interactive can be found at https://www.nobelprize.org/educational/medicine/dna_double_helix/dnahelix.html

- Oompa Loompa Genetics and other activities This is a student worksheet that covers basic crosses and problem sets. The worksheet may be accessed through this link: https://www.biologycorner.com/lesson-plans/genetics/

- Golden Rice- Evaluating the Pros and Cons Students evaluate the evidence and arguments related to Vitamin A deficiency. There is a student handout and a teacher guide to the activity. The handouts may be found at: http://serendip.brynmawr.edu/exchange/bioactivities/GoldenRice

Resources
• DNA Replication: The Cell's Extreme Sport This video models copying genetic material to prepare for mitosis. This video is available from https://www.youtube.com/watch?v=5qSrmeiWsuc&index=11&list=PLwL0Myd7Dk1F0iQPGrjehze3eDpco1eVz • DNA is a Structure That Encodes Biological Information This website contains information, as well as a video showing the relationship between DNA and chromosomes. This video is available from http://www.nature.com/scitable/topicpage/dna-is-a-structure-that-encodes-biological-6493050 • DNA - Breaking the Code Lesson plans will assist students in developing models for the relationship between DNA, genes, and chromosomes. It includes guiding questions, activities, and formative and summative assessments. This resource can be found at http://www.cpalms.org/Public/PreviewResourceLesson/Preview/75807
Sample Formative Assessment Tasks/Questions **Additional sample formative assessment tasks/questions for grade bands are located at the end of each of the SEP Support Doc (http://ed.sc.gov/scdoe/assets/File/instruction/standards/Science/Support%20Documents/Complete_2014SEPsGuide_SupportDoc2_0.pdf)**
• Flow map Create a flow chart sequencing the phases of DNA replication. Students should be directed to include each process of DNA replication. Possible technology integration include using Microsoft Word flow chart option, Prezi.com or Creately.com to produce the chart. • Exit slips Examples 1) Give students three statements, two true and one false. 2) List two things you learned and one that you want to know more about. 3) Quick write - Have students respond to an open-ended question or prompt before, during or after the lesson. • 3D model of DNA Presentation Students use their 3D model of DNA (see possible instructional strategies) to create a presentation (live or video) that explains the relationship between DNA, genes, and chromosomes and models how DNA is replicated. *This strategy is also included in H.B.4B.

Unit Title
Biology: Heredity - Inheritance and Variation of Traits
Standard **http://ed.sc.gov/scdoe/assets/file/agency/ccr/Standards-Learning/documents/South_Carolina_Academic_Standards_and_Performance_Indicators_for_Science_2014.pdf**
H.B.4 The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one

generation to the next via genes.

Conceptual Understanding

H.B.4B In order for information stored in DNA to direct cellular processes, a gene needs to be transcribed from DNA to RNA and then must be translated by the cellular machinery into a protein or an RNA molecule. The protein and RNA products from these processes determine cellular activities and the unique characteristics of an individual. Modern techniques in biotechnology can manipulate DNA to solve human problems.

New Academic Vocabulary

Some students may need extra support with the following academic vocabulary in order to understand what they are being asked to understand and do. Teaching these terms in an instructional context is recommended rather than teaching the words in isolation. A great time to deliver explicit instruction for the terms would be during the modeling process. Ultimately, the student should be able to use the academic vocabulary in conversation with peers and teachers. These terms are pulled from the essential knowledge portion of the Support Doc 2.0 (http://ed.sc.gov/instruction/standards-learning/science/support-documents-and-resources/) and further inquiry into the terms can be found there.

Transcription	Peptide bond	Gel Electrophoresis	Codon	Biotechnology
Translation	Amino acid	DNA fingerprinting	Messenger RNA	Genetic Engineering
Ribosomal RNA	Stop codon	Genome	Transfer RNA	Plasmid
Anticodon	Restriction enzyme	Recombinant DNA	Restriction enzyme	Genetically-modified organism

Performance Indicators

Text highlighted below in *orange* and *italicized/underlined* shows connections to SEP's

H.B.4B.1 *Develop and use models to* describe how the structure of DNA determines the structure of resulting proteins or RNA molecules that carry out the essential functions of life.

H.B.4B.2 *Obtain, evaluate and communicate information* on how biotechnology (including gel electrophoresis, plasmid-based transformation and DNA fingerprinting) may be used in the fields of medicine, agriculture, and forensic science.

***Science and Engineering Practices**

Support for the guidance, overviews of learning progressions, and explicit details of each SEP can found in the Science and Engineering Support Doc (http://ed.sc.gov/scdoe/assets/File/instruction/standards/Science/Support%20Documents/Complete_2014SEPsGuide_SupportDoc2_0.pdf). It is important that teachers realize that the nine science and engineering practices are not intended to be used in isolation. Even if a performance indicator for a given standard only lists one of the practices as a performance expectation, scientists and engineers do not use these practices in isolation, but rather as part of an overall sequence of practice. When educators design the learning for

their students, it is important that they see how a given performance expectation fits into the broader context of the other science and engineering practices. This will allow teachers to provide comprehensive, authentic learning experiences through which students will develop and demonstrate a deep understanding of scientific concepts.

H.B.1A.2 Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others.

H.B.1A.8 Obtain and evaluate scientific information to (1) answer questions, (2) explain or describe phenomena, (3) develop models, (4) evaluate hypotheses, explanations, claims, or designs or (5) identify and/or fill gaps in knowledge. Communicate using the conventions and expectations of scientific writing or oral presentations by (1) evaluating grade-appropriate primary or secondary scientific literature, or (2) reporting the results of student experimental investigations.

***Cross Cutting Concepts** **(http://www.nap.edu/read/13165/chapter/8)**

The link above provides support from the Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (2012) The text in blue and *italicized/underlined* below provides a brief explanation of how the specific content ties to the CCC's.

2. *Cause and effect:* The National Research Council (2012) states "events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts" (p. 84). *Transcription occurs and mRNA leaves nucleus to attach to the ribosome and translation begins.*

3. Scale, proportion, and quantity: The National Research Council (2012) states that "in considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance" (p. 84). *The mRNA codon is comprised of three mRNA bases, and they code for a particular amino acid.*

4. Systems and systems models: The National Research Council (2012) states that "Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering" (p. 84). *Because DNA is unable to leave the nucleus, its message is encoded in mRNA and sent to the ribosome. mRNA codons code for the correct amino acids that are picked up by tRNA molecule and carried to the ribosome.*

6. Structure and function: The National Research Council (2012) states that "the way in which an object or living thing is shaped and its substructure determine many of its properties and functions " (p. 84). *Due to its double helix structure, DNA is unable to leave the nucleus. Therefore, it must encode its message in mRNA, which can leave the nucleus.*

**Teachers have the discretion to enhance the selected SEP's and CCC's.*

Prior Knowledge
• 7.L.4A DNA and RNA • 7.L.4A.6 DNA and RNA, Biotechnology, Selective Breeding, Genetic Engineering, and Biomedical Research
Subsequent Knowledge
• N/A

Possible Instructional Strategies/Lessons
Strategies and lessons that will enable students to master the standard and/or indicator.

- 3D DNA Model Students construct a 3D model of DNA using whatever materials are available. The strands of the model should be able to separate in order to show how transcription can occur and lead to translation and the creation of a protein. *This strategy is also included in H.B.4A.

- Build A Bug with DNA Lab Students are provided a strand of DNA. They will transcribe and translate to the amino acid sequence to discover the traits of the bug. There are many versions of this lab available online. One version can be found at https://www.fsd1.org/schools/southflorence/rdantzler/Documents/Build%20a%20Bug%20requirements.pdf.

- Storyboard transcription and translation This strategy creates a visual of how DNA's structure determines the structure of proteins and/or RNA. The process does not seem so microscopic.

- Codon Bingo Students actively participate in illustrating how DNA's structure determines protein/RNA structure by filling their bingo board with amino acids. The teacher calls out the codon, and students try to get BINGO by matching the amino acid with the codon. This can be found at http://www.otago.ac.nz/genetics/otago038346.pdf .

- Protein Synthesis Makes Sense! Using a code specified by the activity, students model the connection between DNA structure and protein structure by building sentences instead of proteins. This activity is available at http://www.zerobio.com/drag_oa/protein/overview.htm

- *Hunger Games* Science This website communicates information with genetically-engineering organisms using the *Hunger Games*. Link can be found at http://learning.blogs.nytimes.com/2012/05/16/hunger-games-science-investigating-genetically-engineered-organisms/?_r=0.

- Classzone.com Students are able to evaluate the biotechnology resources as they participate in virtual labs, i.e. gel electrophoresis lab and bacteria formation. They receive experience with the gel electrophoresis procedure. They are walked through the process of forming a plasmid. This can be found at http://www.classzone.com.

Resources

- Drag and Drop Protein Synthesis Students get interactive practice with transcription and translation, the relationship between the structure of DNA and the structure of proteins/RNA. They are able to check their answers for immediate feedback. This interactive is available at http://www.zerobio.com/drag_oa/protein/overview.htm

- DNA to Protein This is an interactive that allow students to dive into the cell and visualize the process as it happens. This interactive is available at https://concord.org/stem-resources/dna-protein-0

- Why RNA is just as cool as DNA This Amoeba Sisters video explains how the structure of DNA determines the structure of RNA and how transcription occurs. This video is available from https://www.youtube.com/watch?v=0Elo-zX1k8M&index=3&list=PLwL0Myd7Dk1HK8gH2XIafNgQJD1dMX2aW

- Protein Synthesis and the Lean, Mean, Ribosome Machines This Amoeba Sisters video continues from the previous one explaining how the process of translation leads to the production of proteins. Both this video and the previous one together can be used to inform a discussion of how the structure of DNA determines the structure of the resulting RNA and protein. This video is available from https://www.youtube.com/watch?v=h5mJbP23Buo

Sample Formative Assessment Tasks/Questions

Additional sample formative assessment tasks/questions for grade bands are located at the end of each of the SEP Support Doc (http://ed.sc.gov/scdoe/assets/File/instruction/standards/Science/Support%20Documents/Complete_2014SEPsGuide_SupportDoc2_0.pdf)

- 3D model of DNA Presentation Students use their 3D model of DNA (see possible instructional strategies) to create a presentation (live or video) that explains the relationship between the structure of DNA and the structure of the resulting RNA and proteins. *This strategy is also included in H.B.4A

- Biotechnology Research Project Students select a specific biotechnology (Gel Electrophoresis, bacterial transformation, or DNA fingerprinting) and research how this technology is used in one of the fields of medicine, agriculture, or forensics. Students will then create a product (paper, presentation, video, etc.) to report their findings.

- Biotechnology Debate Students select a side (pro or con) about the use of a specific biotechnology (gel electrophoresis, bacterial transformation, or DNA fingerprinting) in a specific field (medicine, agriculture, or forensics) to research and perform a debate.

Unit Title
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Standard http://ed.sc.gov/scdoe/assets/file/agency/ccr/Standards-Learning/documents/South_Carolina_Academic_Standards_and_Performance_Indicators_for_Science_2014.pdf
H.B.4 The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes.

Conceptual Understanding
H.B.4C Sex cells are formed by a process of cell division in which the number of chromosomes per cell is halved after replication. With the exception of sex chromosomes, for each chromosome in the body cells of a multicellular organism, there is a second similar, but not identical, chromosome. Although these pairs of similar chromosomes can carry the same genes, they may have slightly different alleles. During meiosis the pairs of similar chromosomes may cross and trade pieces. One chromosome from each pair is randomly passed on to form sex cells resulting in a multitude of possible genetic combinations. The cell produced during fertilization has one set of chromosomes from each parent.
New Academic Vocabulary **Some students may need extra support with the following academic vocabulary in order to understand what they are being asked to understand and do. Teaching these terms in an instructional context is recommended rather than teaching the words in isolation. A great time to deliver explicit instruction for the terms would be during the modeling process. Ultimately, the student should be able to use the academic vocabulary in conversation with peers and teachers. These terms are pulled from the essential knowledge portion of the Support Doc 2.0 (http://ed.sc.gov/instruction/standards-learning/science/support-documents-and-resources/) and further inquiry into the terms can be found there.**

Meiosis	Diploid	Fertilization	Daughter Cells	Gametes
Sex Cells	Prophase I	Homologous Chromosomes	Sister Chromatids	Centromere
Crossing Over	Metaphase I	Independent Assortment	Anaphase I	Telophase I
Cytokinesis	Haploid	Prophase II	Metaphase II	Anaphase II

Telophase II

Performance Indicators

Text highlighted below in *orange* and *italicized/underlined* shows connections to SEP's.

H.B.4C.1 *Develop and use models* of sex cell formation (meiosis) to explain why the DNA of the daughter cells is different from the DNA of the parent cell.

H.B.4C.2 *Analyze data* on the variation of traits among individual organisms within a population to explain the patterns in the data in the context of transmission of genetic information.

H.B.4C.3 *Construct explanations* for how meiosis followed by fertilization ensures genetic variation among offspring within the same family and genetic diversity within populations of sexually reproducing organisms.

***Science and Engineering Practices**

Support for the guidance, overviews of learning progressions, and explicit details of each SEP can found in the Science and Engineering Support Doc (http://ed.sc.gov/scdoe/assets/File/instruction/standards/Science/Support%20Documents/Complete_2014SEPsGuide_SupportDoc2_0.pdf). It is important that teachers realize that the nine science and engineering practices are not intended to be used in isolation. Even if a performance indicator for a given standard only lists one of the practices as a performance expectation, scientists and engineers do not use these practices in isolation, but rather as part of an overall sequence of practice. When educators design the learning for their students, it is important that they see how a given performance expectation fits into the broader context of the other science and engineering practices. This will allow teachers to provide comprehensive, authentic learning experiences through which students will develop and demonstrate a deep understanding of scientific concepts.

H.B.1A.2 Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others.

H.B.1A.4 Analyze and interpret data from informational texts and data collected from investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning, (2) support or refute hypotheses, explanations, claims, or designs, or (3) evaluate the strength of conclusions.

H.B.1A.6 Construct explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams.

***Cross Cutting Concepts** **(http://www.nap.edu/read/13165/chapter/8)**

The link above provides support from the Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (2012) The text in blue and *italicized/underlined* below provides a brief explanation of how the specific content ties to the CCC's.

2. Cause and effect: The National Research Council (2012) states "events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts" (p. 84). *Crossing over causes genetic variation which results in new combinations of genes.*

3. Scale, proportion, and quantity: The National Research Council (2012) states that "in considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance" (p. 84). *Four cells containing half of the number of chromosomes as the original parent cell are formed during meiosis.*

4. Systems and systems models: The National Research Council (2012) states that "Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering" (p. 84). *Homologous chromosomes contain all of the genetic information for an organism.*

6. Structure and function: The National Research Council (2012) states that "the way in which an object or living thing is shaped and its substructure determine many of its properties and functions " (p. 84). *Homologous chromosomes are pairs of chromosomes; one member of the pair containing mom's genetic information and the other member of the pair containing dad's genetic information.*

**Teachers have the discretion to enhance the selected SEP's and CCC's.*

Prior Knowledge
• 7.L.4A.1 Sex Cells as Egg or Sperm • 7.L.4A.2 Inheritance of Traits • 7.L.4A.3 Punnett Squares • 7.L.4A.4 Probability of Genotype and Phenotype
Subsequent Knowledge
• N/A

Possible Instructional Strategies/Lessons **Strategies and lessons that will enable students to master the standard and/or indicator.**
• Draw the stages of meiosis The teacher can have students draw stages of meiosis with chalk, markers, colored pencils, yarn/pipe cleaners etc. on the sidewalk, poster paper, flip book, etc. They can color-code structures, i.e. homologous chromosomes - red. • Genetics in Harry Potter's World Lesson2 In this activity, students will determine traits for the creatures and characters in the *Harry Potter* series by constructing Punnett squares with multiple alleles, polygenic traits, etc. This activity is available at https://www.nlm.nih.gov/exhibition/harrypottersworld/pdf/lesson2.pdf

- Multiple Alleles: Using Blood Types to Solve a Mystery Students will use Punnett Squares containing multiple alleles as evidence/data for their scientific argument. This activity is available at http://archives.lessoncorner.com/29dc5ea364d538a6d.pdf

- Are You Color Blind? And Other Sex-Linked Traits Students will use manipulatives to model the passage of sex-linked traits. Also, they will determine the genotypes and phenotypes of some Royal European families in terms of hemophilia. This activity is available at http://archives.lessoncorner.com/6a483660b00274ebc.pdf

- Pick the Risk: The Polygenic Pedigree Challenge Students use color-coded pom-poms to determine how susceptible individuals are to multiple allele disorders. This activity is available at http://learn.genetics.utah.edu/content/basics/activities/pdfs/Pick%20the%20Risk_Public.pdf

- Hemophilia: The Royal Disease Students investigate the inheritance of hemophilia in the royal families of Europe through pedigree analysis. This is available from http://sciencecases.lib.buffalo.edu/cs/files/hemo.pdf

Resources

- Meiosis Animation The animation illustrates the entire process of meiosis and allows students to see the homologous chromosomes. This animation is available on http://www.sumanasinc.com/webcontent/animations/content/meiosis.html

- Snurfle Meiosis This interactive provides animations and quizzes for the students. It walks students through the phases of meiosis and chromosome structure and number. This interactive is available at http://www.biomanbio.com/GamesandLabs/Genegames/snurfle_meiosis_and_genetics.html

- Meiosis: The Great Divide This Amoeba Sisters video models the process of meiosis. This video is available at https://www.youtube.com/watch?v=toWK0flyFlY&index=14&list=PLwL0Myd7Dk1F0iQPGrjehze3eDpco1eVz

- Chromosome Numbers During Division: Demystified! This Amoeba Sisters video clarifies the movement of chromosomes and the numbers of chromosomes in the cells during and after mitosis and meiosis and independent assortment. This video is available at https://www.youtube.com/watch?v=gcz1FOWw0Cg&index=15&list=PLwL0Myd7Dk1F0iQPGrjehze3eDpco1eVz

Sample Formative Assessment Tasks/Questions

Additional sample formative assessment tasks/questions for grade bands are located at the end of each of the SEP Support Doc (http://ed.sc.gov/scdoe/assets/File/instruction/standards/Science/Support%20Documents/Complete_2014SEPsGuide_SupportDoc2_0.pdf)

- Games with the stages of meiosis Meiosis Memory, Meiosis Pictionary will allow students to visualize the difference between the daughter cell DNA and the parent cell DNA.

- Flow map of Meiosis Students will develop a model of why the DNA of daughter cells produced by meiosis are different from the DNA of the parent cell. Students should include a discussion of how this leads to variation within families and genetic diversity in populations. Students and teacher can refer to the Chromosome Numbers During Division Demystified video (see resources).

- Meiosis I & Meiosis II T chart This assessment will allow students to determine how and when the DNA from the parent cell becomes different from the DNA of the daughter cell.

- Hemophilia: The Royal Disease Students answer questions based on an analysis of the pedigree of hemophilia in the royal families of Europe. This is available from http://sciencecases.lib.buffalo.edu/cs/files/hemo.pdf

- Personal Pedigree Students will analyze data on trait variation by researching their family for a particular trait and creating a pedigree. Students will compare traits among the classroom.

Unit Title

Biology: Heredity - Inheritance and Variation of Traits

Standard

http://ed.sc.gov/scdoe/assets/file/agency/ccr/Standards-Learning/documents/South_Carolina_Academic_Standards_and_Performance_Indicators_for_Science_2014.pdf

H.B.4 The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes.

Conceptual Understanding

H.B.4D Imperfect transmission of genetic information may have positive, negative, or no consequences to the organism. DNA replication is tightly regulated and remarkably accurate, but errors do occur and result in mutations which (rarely) are a source of genetic variation.

New Academic Vocabulary

Some students may need extra support with the following academic vocabulary in order to understand what they are being asked to understand and do. Teaching these terms in an instructional context is recommended rather than teaching the words in isolation. A great time to deliver explicit instruction for the terms would be during the modeling process. Ultimately, the student should be able to use the academic vocabulary in conversation with peers and teachers. These terms are pulled from the essential knowledge portion of the Support Doc 2.0 (http://ed.sc.gov/instruction/standards-learning/science/support-documents-and-resources/) and further inquiry into the terms can be found there.

Mutation	Somatic Cell	Sex Cell	Gamete	Gene Mutation
Genetic Disorders	Sickle Cell Disease	Tay-Sachs Disease	Huntington's Disease	Cystic Fibrosis
Hemophilia A	Albinism	Chromosomal Mutation	Klinefelter Syndrome	Turner's Syndrome
Down's Syndrome	Point Mutation	Frameshift Mutation		

Performance Indicators

Text highlighted below in *orange* and *italicized/underlined* shows connections to SEP's.

H.B.4D.1 *Develop and use models* to explain how mutations in DNA that occur during replication (1) can affect the proteins that are produced or the traits that result and (2) may or may not be inherited.

***Science and Engineering Practices**

Support for the guidance, overviews of learning progressions, and explicit details of each SEP can found in the Science and Engineering Support Doc (http://ed.sc.gov/scdoe/assets/File/instruction/standards/Science/Support%20Documents/Complete_2014SEPsGuide_SupportDoc2_0.pdf). It is important that teachers realize that the nine science and engineering practices are not intended to be used in isolation. Even if a performance indicator for a given standard only lists one of the practices as a performance expectation, scientists and engineers do not use these practices in isolation, but rather as part of an overall sequence of practice. When educators design the learning for their students, it is important that they see how a given performance expectation fits into the broader context of the other science and engineering practices. This will allow teachers to provide comprehensive, authentic learning experiences through which students will develop and demonstrate a deep understanding of scientific concepts.

H.B.1A.2 Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others.

***Cross Cutting Concepts** **(http://www.nap.edu/read/13165/chapter/8)**

The link above provides support from the Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (2012) The text in blue and *italicized/underlined* below provides a brief explanation of how the specific content ties to the CCC's.

2. *Cause and effect*: The National Research Council (2012) states "events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be

tested across given contexts and used to predict and explain events in new contexts" (p. 84). *If there is a change in the DNA (during replication), then the result is a mutation that could benefit the organism or harm the organism.*

3. Scale, proportion, and quantity: The National Research Council (2012) states that "in considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance" (p. 84). *Mutations can occur in a single nucleotide, a sequences of nucleotides, or a whole chromosome.*

4. Systems and systems models: The National Research Council (2012) states that "Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering" (p. 84). *Mutations that occur in DNA can affect the whole organism.*

6. Structure and function: The National Research Council (2012) states that "the way in which an object or living thing is shaped and its substructure determine many of its properties and functions " (p. 84). *The change in the structure of DNA will lead to improper coding of the amino acid sequence, consequently the trait.*

**Teachers have the discretion to enhance the selected SEP's and CCC's.*

Prior Knowledge
• 7.L.4A.5 Gene Mutations
Subsequent Knowledge
• N/A

Possible Instructional Strategies/Lessons
Strategies and lessons that will enable students to master the standard and/or indicator.

- The Molecular Biology of Mutations and Muscular Dystrophy In this activity, students will be exposed to five types of mutations. Then, students decode each mutation for a type of Muscular Dystrophy. This activity is available at http://serendip.brynmawr.edu/exchange/bioactivities/mutation

- Mutations Activity This activity walks students through each type of mutation. Students are instructed to manipulate the DNA to create the mutation. This activity is available at http://www.tamdistrict.org/cms/lib8/CA01000875/Centricity/Domain/654/Mutations%20Activity.pdf

- Karyotyping Activity In this interactive, students are required to complete three karyotypes. They must determine the disorder from the missing chromosome. This interactive is available at http://www.biology.arizona.edu/human_bio/activities/karyotyping/karyotyping.html

- Human Karyotyping Activity In this activity, students cut, paste, and assemble a human karyotype to determine a particular disorder. This activity is available at http://www3.nd.edu/~nismec/biomodel/mod9/9%20Human%20Karyotyping%20Activity.pdf

Resources

- Mutations In the interactive, students create mutations in a DNA strand by inserting, deleting, or substituting nucleotides. This interactive is available at https://concord.org/stem-resources/mutations

- Mutations: The Potential Power of Small Change This Amoeba Sisters video models how small changes in DNA can lead to big changes in proteins and living things. This video is available from https://www.youtube.com/watch?v=GieZ3pk9YVo&list=PLwL0Myd7Dk1F0iQPGrjehze3eDpco1eVz&index=24

- Drag-and-Drop Karyotype This interactive allows students to become familiar with the DNA banding of homologous pairs of chromosomes. This interactive is available at http://www.zerobio.com/karyotype_drag_and_drop.swf

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- Genetic Disorders and Diseases Presentation Provide students with a list of genetic disorders or diseases caused by various mutations. Students will select one item from the list to research. Students will research the genetic cause of the disease, including the type of mutation that caused it, and how this mutation has led to alterations in protein structure or inherited traits and how the disorder may or may not be inherited. Students will then present their findings (live or video).

References

Aronova-Tiuntseva, Y. & Herreid, C.F. (2003). Hemophilia: The royal disease [PDF document]. National Center for Case Study Teaching in Science. Retrieved August 24, 2016 from http://sciencecases.lib.buffalo.edu/cs/files/hemo.pdf

Are You Color Blind? And Other Sex-Linked Traits. [PDF document]. (n.d.). Retrieved August 11, 2016 from http://archives.lessoncorner.com/6a483660b00274ebc.pdf

Build A Bug! Protein Synthesis: Transcribing and translating the DNA code. [PDF document]. (n.d.). Retrieved August 3, 2016 from https://www.fsd1.org/schools/southflorence/rdantzler/Documents/Build%20a%20Bug%20requirements.pdf

Cobb, Laquette. (2005). DNA: Breaking the Code! *CPALMS.* Retrieved August 24, 2016 http://www.cpalms.org/Public/PreviewResourceLesson/Preview/75807

Cutraro, J. & Schulten, K. (2012, May 16). 'Hunger Games' Science: Investigating Genetically Engineered Organisms. *The New York Times.* Retrieved August 3, 2016 from http://learning.blogs.nytimes.com/2012/05/16/hunger-games-science-investigating-genetically-engineered-organisms/?_r=0

DNA is a structure that encodes biological information. (2014). *Scitable.* Retrieved August 10, 2016 from http://www.nature.com/scitable/topicpage/dna-is-a-structure-that-encodes-biological-6493050

DNA - The double helix game. (2016). *Nobelprize.org.* Retrieved August 10, 2016 from https://www.nobelprize.org/educational/medicine/dna_double_helix/dnahelix.html

DNA to protein. (2013). *The Concord Consortium.* Retrieved August 10, 2016 from https://concord.org/stem-resources/dna-protein-0

Genetics in *Harry Potter's* World Lesson 2. (2016). *U.S. National Library of Medicine.* Retrieved August 11, 2016 from https://www.nlm.nih.gov/exhibition/harrypottersworld/pdf/lesson2.pdf

Gordon, A. (n.d.). Protein synthesis makes sense! [Word document]. Retrieved August 10, 2016 from http://www4.esc13.net/uploads/science/docs/manipulatives/protein_synthesis_makes_sense_instructions.pdf

Gorleau, Rick. (2001, April 17). Journey Into Human DNA. Nova. Retrieved August 3, 2016 from http://www.pbs.org/wgbh/nova/body/journey-into-human-dna.html.

Kimmel,E. (n.d.). Karyotype Activity. Retrieved August 13, 2016 from http://www.zerobio.com/karyotype_drag_and_drop.swf

Kimmel, K. (2008). Drag and drop protein synthesis. Retrieved August 10, 2016 from http://www.zerobio.com/drag_oa/protein/overview.htm

Mannix, C. (1994). Codon Bingo. *Woodrow Wilson Biology Institute.* Retrieved August 3, 2016 from http://www.otago.ac.nz/genetics/otago038346.pdf

Multiple Alleles [PDF document]. (n.d.). Retrieved August 11,2016 from http://archives.lessoncorner.com/29dc5ea364d538a6d.pdf

Muskopf, Shannan. (n.d.) Oompa Loompa Genetics. *Biologycorner.com*. Retrieved August 24, 2016 from https://www.biologycorner.com/worksheets/genetics_oompa.html

Mutations. (2016). *The Concord Consortium.* Retrieved August 13, 2016 from https://concord.org/stem-resources/mutations

Mutations Activity [PDF document]. (n.d.). Retrieved August 13, 2016 from http://www.tamdistrict.org/cms/lib8/CA01000875/Centricity/Domain/654/Mutations%20Activity.pdf

National Research Council. A Framework for k-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Washington, DC: The National Academies Press, 2012. doi: 10.17226/13165.

Peterson, S. & Rapini, B. (2014). DNA replication: The cell's extreme sport [Video]. Amoeba Sisters. Retrieved August 3, 2016 from https://www.youtube.com/watch?v=5qSrmeiWsuc&index=11&list=PLwL0Myd7Dk1F0iQPGrjehze3eDpco1eVz

Peterson, S. & Rapini, B. (2014). Meiosis: The great divide [Video]. Amoeba Sisters. Retrieved August 24, 2016 from https://www.youtube.com/watch?v=toWK0flyFlY&index=14&list=PLwL0Myd7Dk1F0iQPGrjehze3eDpco1eVz

Peterson, S. & Rapini, B. (2014). Protein synthesis and the lean, mean, ribosome machines [Video]. Amoeba Sisters. Retrieved August 24, 2016 from https://www.youtube.com/watch?v=0Elo-zX1k8M&index=3&list=PLwL0Myd7Dk1HK8gH2XIafNgQJD1dMX2aW

Peterson, S. & Rapini, B. (2014). Why RNA is just as cool as DNA [Video]. Amoeba Sisters. Retrieved August 24, 2016 from https://www.youtube.com/watch?v=0Elo-zX1k8M&index=3&list=PLwL0Myd7Dk1HK8gH2XIafNgQJD1dMX2aW

Pick the Risk: The Polygenic Pedigree Challenge. (2008). *Genetic Science Learning Center.* Retrieved August 11, 2016 from http://learn.genetics.utah.edu/content/basics/activities/pdfs/Pick%20the%20Risk_Public.pdf

Sadava, *et al.* (2010). Meiosis. *Life: The Science of Biology.* Retrieved August 11, 2016 from http://www.sumanasinc.com/webcontent/animations/content/meiosis.html

Snurfle Meiosis and Genetics. (n.d.). *Bioman Biology.* Retrieved August 11, 2016 from http://www.biomanbio.com/GamesandLabs/Genegames/snurfle_meiosis_and_genetics.html

Virtual Labs. (2008). *Classzone.* McDougal-Littell. Retrieved August 3, 2016 from http://www.classzone.com

Waldron, I. (2014). Golden Rice- Evaluating the Pros and Cons. *Serendip Studio.* Retrieved August 24, 2016 from http://serendip.brynmawr.edu/exchange/bioactivities/GoldenRice

Waldron, I. (2011). The Molecular Biology of Mutations and Muscular Dystrophy. *Serendip Studio.* Retrieved August 13, 2016 from http://serendip.brynmawr.edu/exchange/bioactivities/mutation

Warren, D. (1996). Karyotyping Activity. *The Biology Project.* Retrieved August 13, 2016 from http://www.biology.arizona.edu/human_bio/activities/karyotyping/karyotyping.html